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THIRTIETH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER CO.

ON

105 MM BATTALION ANTI-TANK PROJECT

Contract No.
DA-33-019-ORD-33 (Negotiated)
RAD ORDTS 1-12383

THE FIRESTONE TIRE & RUBBER CO.
Defense Research Division
Akron, Ohio

JANUARY, 1953

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INDEX

ABSTRACT

An inventory of recoilless rifles and mounts manufactured by Firestone for the BAT and ONTOS projects is presented.

The peak pressure has been measured at each of several stations in the T137E1 rifle. Both copper and piezo gages were used. The test results are presented and discussed.

A program for the further development of the T138 projectile, involving long range accuracy tests, is proposed.

Determination of the strength of the component parts of the T119 projectile has continued. Tests of the piston of the fin opening mechanism are described. Planning is given for the investigation of four phases of the T119 projectile development - length of projectile, number and size of fins, fuzing and howitzer firing. An accounting of projectile shipments is presented.

Two important phases of penetration studies were investigated: Test data showing the effect of a fuze wire on the liner axis are reported and discussed. The study of the effect of interior tee configuration on penetration was continued and the test results are discussed.

Safety tests on the T222E5 base elements were conducted by Picatinny Arsenal. None of them armed or suffered any damage. A switch for the T267 superquick and delay fuze is illustrated and described. Tests were conducted to compare the voltage output of two nose element designs, and functioning tests were conducted with one. The results are presented. Tests were conducted to determine the applicability of a selenium rectifier and a condenser in a setback-actuated electric fuze for a proposed HEAT shell arrangement. The test results are given.

THE WEAPON SYSTEM

An inventory of recoilless rifles and mounts manufactured by Firestone for the BAT and ONTOS projects is presented in Table I.

Table I
Inventory of Recoilless Rifles and Mounts
Manufactured by Firestone for BAT and ONTOS Projects

Rifle or Mount	Location	Comments
T137E3 Rifles		
Ser. No. 1	Akron	Returned from Fort Benning
2	Akron	Returned from Fort Benning
3	Allis-Chalmers	T165 Serial No. 5
4	Allis-Chalmers	T165 Serial No. 7
5	Allis-Chalmers	Shipped 1-17-53
6	Allis-Chalmers	T166 Serial No. 2
7	Allis-Chalmers	T165 Serial No. 6
8	Allis-Chalmers	T165 Serial No. 5
9	Allis-Chalmers	T165 Serial No. 6
10	Allis-Chalmers	T166 Serial No. 3
11	Allis-Chalmers	T165 Serial No. 7
12	Not Completed	
13	Aberdeen Proving Ground	BAT Engineering Test
14	Akron	Proofed and ready for shipment to Allis-Chalmers
15	Allis-Chalmers	Shipped 1-17-53
16-25, incl.	Not Completed	
T137E2 Rifles		
Ser. No. 1	Akron	Used for spare parts
2	"	E.O.D. for test facility.
T137E1 Rifles		
Ser. No. 1	Akron	To be salvaged
2	Akron	" " "
3	Akron	" " "
4	Watertown Arsenal	To be returned to Firestone on completion of metallurgical study.
5	Akron	To be salvaged
6	"	" " "
7	"	" " "
8	"	" " "
T137 Rifle		
Ser. No. 1	Akron	Destroyed in proofing
T152E5 Mounts		
Ser. No. 1	Akron	
2	Akron	
3	Aberdeen Proving Ground	BAT Engineering Test
T152E4 Mounts		
Ser. No. 1	Allis-Chalmers	T165 Serial No. 5
2	Allis-Chalmers	T165 Serial No. 6
3	Allis-Chalmers	T166 Serial No. 2
4	Allis-Chalmers	T166 Serial No. 3
5	Allis-Chalmers	T165 Serial No. 7
6	Allis-Chalmers	Shipped 1-17-53
7	Akron	Proofed and ready for shipment to Allis-Chalmers
8-12, incl.	Not Completed	
T152E3 Mounts		
Ser. No. 1	Akron	To be salvaged
2	Akron	Converted to E4
3	Akron	Converted to E4
4	Akron	To be salvaged
T152E2 Mounts		
Ser. No. 1	Akron	To be salvaged
2	Akron	Salvaged
T152E1 Mount		
Ser No. 1	Akron	Salvaged
T152 Mount		
Ser. No. 1	Akron	Salvaged

Pressure Distribution, T137E1 Rifle

Nine pressure stations were installed in a T137E1 rifle; four were located in the chamber and five in the tube, as shown in Fig. 1. The pressure distribution in the rifle was obtained, using both copper and piezo gages. Pressure readings were also obtained using M-3 type internal pressure gages. To insure that the external copper pressure gages were operating in the proper range of copper deformation, two gages were used on each round, one having a piston area of 1/6 sq in and the other an area of 1/15 sq in. The two external copper pressure gages and the piezo gage were cycled so that each gage was at each station for at least one round. The charge used was 8 lb 1 oz of M10, MP, .0335-in web powder. Projectiles were 17.5 lb slugs. Table II and Fig. 2 summarize the results obtained.

Several observations may be made from these data:

(1) The copper crusher gage with a 1/15 sq in piston gives substantially the same results as the gage with a 1/6 sq in piston in the range of pressures involved.

(2) The internal pressure gages (M-3) indicate pressures about 20% higher than external gages mounted on the chamber.

(3) Piezo gage readings on the chamber are about 10% higher than copper crusher but 7% lower than internal (M-3) type copper gage readings.

It is of interest to note that a pressure differential of about 2,000 lb/sq in apparently exists between the inside and outside of the shell case. Since the pressures measured are peak pressures only, and since the internal pressure rise must be ahead of the external pressure rise, it is likely that the actual instantaneous difference in pressure between the inside and outside of the shell case is somewhat in excess of 2,000 lb/sq in. A pressure of 2,000 lb/sq in inside a cylinder with the dimensions of a shell case would cause a stress of about 50,000 lb/sq in in the case which approaches the yield strength of the material in a non-heat treated M32 shell case.

Future Program

Pressure stations will be installed in a T137E3 rifle and the pressure distribution for this rifle determined.

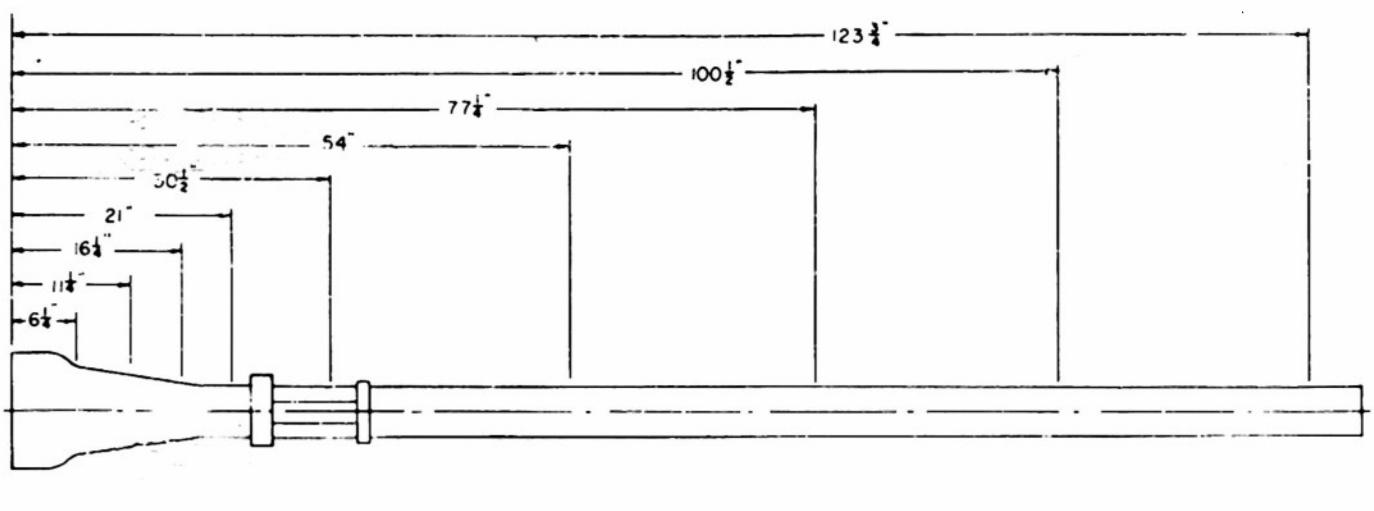

Fig. 1. Pressure Stations, T137E1 Rifle.

Table II
Pressure Distribution, T137E1 Rifle

Station	Pressure – Lbs/Sq. In.		
	Cu. Gage 1/6 sq. in. area	Cu. Gage 1/15 sq. in. area	Piezo Gage
1	8,720	8,900	10,140
1	8,920	9,000	---
2	9,360	9,500	10,220
2	9,080	9,050	---
3	9,240	9,000	---
3	9,260	9,300	---
4	9,000	9,300	9,700
4	9,520	9,300	---
5	8,520	8,750	---
5	8,680	---	---
6	6,960	7,000	---
6	7,000	5,850	---
7	4,720	4,550	5,645
7	5,760	4,700	---
8	3,360	---	4,090
9	2,880	---	3,400

Notes:
1. Charge 8 lb 1 oz PA30240, .0335-in web.
2. Average M-3 internal copper 10,890 lb/sq in.

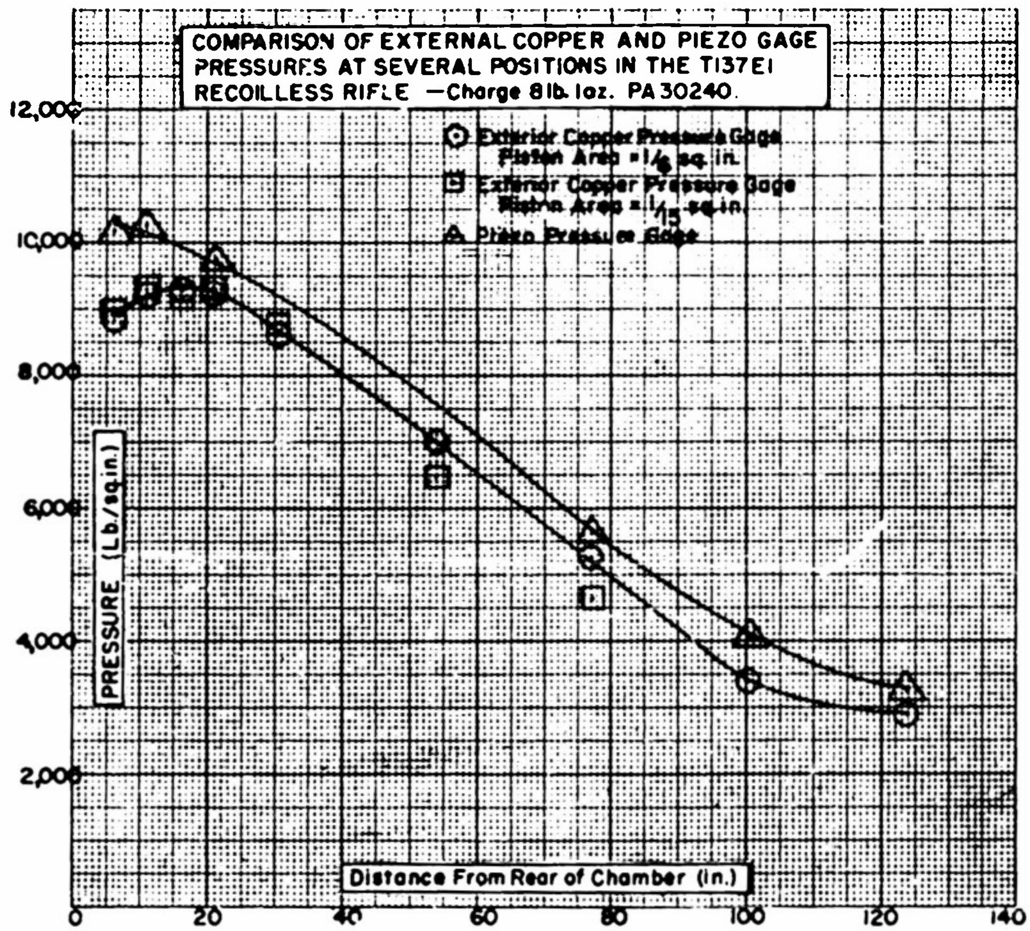

Fig. 2. Comparison of External Copper and Piezo Gage Pressures.
At Several Positions in the T137E1 Recoilless Rifle.

T138 PROJECTILE

Projectiles for determining the effect of center of gravity location and spin rate on the accuracy of the T138 projectile (Twenty-Ninth Progress Report) have been manufactured. The future program is being amplified to include long range accuracy tests. The availability of adequate range facilities for these tests is being determined.

Strength Tests of Piston, DRB198

The strength tests of T119E11 projectiles, described in the Twenty-Ninth Progress Report, indicated that the piston had marginal strength. Fig. 3 shows a typical failure. These tests have been continued, using a 105mm recoilless rifle, T137E3, rather than the howitzer, M2A1, used in earlier tests.

To increase the severity of the test, T119E11 projectiles were fitted with special pistons, each having an orifice diameter of .234 in. instead of the usual .196 in. The large orifice allows the propellent gases to reach a higher pressure in the projectile chamber and thereby increases the severity of the fin-stopping stresses on the piston. Nine projectiles were fired under these conditions and eight piston failures were obtained. The range data are shown in Table III.

A metallographic examination of the piston material (C1141 steel) revealed a coarse grain structure. A number of pistons were therefore heat treated to provide improved ductility and impact strength. The heat treated pistons were tested in T119E11 projectiles by firing at 115 percent of the service charge. For comparison, ten projectiles without heat treated pistons were fired at service charge. None of the pistons having the nominal .196-inch orifice failed, but three of the untreated pistons in the control group did. The range data are shown in Table IV.

Until a new piston, with substantially increased strength can be designed and tested all pistons for T119E11 projectiles will be heat treated.

Complete Piston

Section Through Piston Showing Failure at Neck

Fig. 3. DRB198 Piston From T119E11 Projectiles.

T119 Cartridge Development

Projectile Development

Length - A sample quantity of short T119 cartridges (Twenty-Ninth Progress Report) are being manufactured. The study of projectile length is being extended to also include longer projectiles with 2.5 caliber ogive.

Fins - A firing test of T119 projectiles with shorter fins has been scheduled at Erie Ordnance Depot. Projectiles with fewer than six fins will also be tested. A projectile with three fins retains some degree of stability.

Fuzing - Tests of a new plug-in type nose element are described in detail on page 17 of this report. T119E11 projectiles, with similar nose elements, are being assembled for penetration tests against homogeneous armor plate.

Howitzer Firing Tests - While the preliminary tests of the T119E11 projectile in the howitzer, M2A1, (Twenty-Ninth Progress Report) were not completely satisfactory, they were sufficiently promising to justify further tests. Consequently, these tests will be continued with projectiles and charges modified to correct the deficiencies which appeared in the earlier tests.

Projectile Shipments

Type	Quantity	Shipped To	Date Shipped
T119E11 Inert	200	Picatinny Arsenal	1-15-53
T119E11 Inert	150	Picatinny Arsenal	1-28-53
T119E11 Live	100	Picatinny Arsenal	1-28-53

Table III
Range Data
Piston Tests

Date 12-22-52 Program T119E

Piston Tests

PROJECTILE
Model T119
Type E11
Weight (Nominal) 17.52 lb
C.G. Location ______
Bourrelet Dia (Nom.) 4.190 in. $^{-.002}$
Special Features Blunt Nose
Orifice Dia. = .234 in.

MAGAZINE TEMPERATURE
Max. 70°F
Min. 70°F
Present 70°F
Loading Rm. 74°F
Ambient 46°F

TEST GUN
Model T137E3 No15
Type 105mm Recoilless
Length of Tube 105 in.
Twist of Rifling 1-20
Sighting Equipment M17 Adapted Telescope
Bore Dia. (Lands) 4.134 $^{+.001}$

Tube 288357-0
Chamber 228-838-0
Vent Ring 228-368H
Pendulum Mount

MISCELLANEOUS DATA
Range Recovery Box
Propellant
PA-E-6119 Type M1 MP web .080 in. Charge Wt. 8 lb. 6oz.
PA-30240 Type M1 MP web .056 in. Charge Wt. 8 lb. 4oz.
Proof Director E. Huffman
Observers R. Hoge

Round No	Proj. No.	Proj. Weight (lb)	Powder Charge (lb - oz)	Powder Lot No.	Chamber Pressure	Muzzle Velocity Instr.	Muzzle Velocity Actual (a)	Recoil (in)	Observations
4347-1	X266	17.31	8-6	PA-E-6119	9,800 10,100	–	–	8½R	Piston head broken off.
4348-2	X259	17.24	8-6	"	10,000 10,400	1652	1640	12½R	" " " "
4349-3	X260	17.51	8-6	"	10,300 10,800	–	–	11R	" " " "
4350-4	X261	17.51	8-6	"	10,200 10,400	–	–	8½R	" " " "
4361-5	X268	17.62	8-6	"	10,000 10,900	–	–	15½R	Piston head did not break off
4362-6	X262	17.40	8-6	"	10,000 10,800	–	–	13¼R	Piston head broken off.
4363-7	X267	17.33	8-6	"	10,800 10,800	–	–	13R	" " " "
4364-8	X260	17.36	8-4	PA-30240	12,800 13,100	–	–	9½R	" " " "
4366-9	X264	17.56	9-4	PA-30240	12,100 12,900	–	–	10R	" " " "

a Retardation Factor = 4.0 ft/sec/ft.
Screen distances:
Gun 47.42' | 44.75' | 20' Box

b Mechanically fired by means of a solenoid.

Comments

All projectiles were recovered.
Yaw card fin spread measurements for projectile X258:

Fin Spread (in) - X258		
1st card	2nd card	3rd card
11½	11½	11 3/8
11½	10 7/8	11 3/8
11 5/8	11½	11

Comparator measurement of the recovered piston in projectile X258 showed that the piston neck had elongated.

Signed – O Miller

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Table IV
Range Data
Piston Tests

Date Jan 5 & 6, 1953 Program T119-C-2

PISTON TESTS

PROJECTILE
Model T119
Type 6.11
Weight (Nominal) 17.52 lb
C.G. Location —
Bourrelet Dia (Nom.) 4.130 in. (.002)
Special Features Blunt Nose

TEMPERATURES

	Jan 5	Jan 6
Max.	75°F	80°F
Min.	70°F	71°F
Pres.	70°F	7?°F
Loading Rm	70°F	—
Ambient	18°F	22°F

TEST GUN
Model T187E3 #16
Type 105mm Recoilless
Length of Tube 105 in.
Twist of Rifling 1-20
Sighting Equipment M17 Adapted Telescope
Bore Dia. (Lands) 4.134 (+.001) in.
Pendulum Constant = 2.25 lbs/sec/in

Tube - 228-865-X
Chamber - 228-828-D
Vent Ring - 228-368-N
Pendulum Mount

MISCELLANEOUS DATA
Range Recovery Box
Propellant
PA-E-6119 Type M10 MP web .038 in.
PA 30240 Type M10 MP web .0355 in.
Proof Director E. Huffman
Observers J. Welter

SCREEN DISTANCES
Butt 42.08' 68.78' 25.49 Rear

Round No.	Proj. No.	Proj. Weight (lbs)	Powder Charge (lb - oz)	Powder Lot No.	Chamber Pressure (lb/sq in)	Muzzle Velocity Instr.	Muzzle Velocity Actual (a)	Orifice Dia. (in.)	Recoil (in.)	Fin Spread (in) (b) 1st Yaw Card 1	1st Yaw Card 2	1st Yaw Card 3	2nd Yaw Card 1	2nd Yaw Card 2	2nd Yaw Card 3	Date Fired	Observations
4378 -1	X290*	17.57	8-4	PA-30240	12,800 / —	1725	1756	.234	—	8	8½	10¼	12	12	12	1-6-53	115% charge. Yaw cards show piston failed. Not recovered.
4379 -2	X291*	17.54	8-6	PA-E-6119	10,100 / 10,400	1660	1691	.234	12½R	10⅝	10¾	10⅞	11¾	11½	–	1-6-53	Inconclusive - not recovered
4380 -3	X295*	17.55	8-4	PA-30240	12,400 / 12,000	1776	1807	.196	11¾R	10½	10½	10¾	10½	10¾	–	1-6-53	115% charge. Recovered - satisfactory
4381 -4	X292*	17.54	8-4	PA-30240	12,300 / —	1731	1762	.196	6¼R	10½	10½	10½	11	10¾	–	1-6-53	" " " "
4382 -5	X296*	17.56	8-4	PA-30240	12,600 / 12,600	1737	1768	.196	5R	10¾	10⅝	10⅝	Only one yaw card used on these rounds.			1-6-53	" " " "
4383 -6	X294*	17.54	8-4	PA-30240	12,300 / 13,000	1755	1786	.196	7½R	10½	10½	10⅝				1-6-53	" " " "
4384 -7	X293*	17.62	8-4	PA-30240	11,500 / 13,000	1764	1795	.196	6½R	10½	10½	10⅝				1-6-53	" " " "
4386 -8	X284	17.52	8-6	PA-E-6119	10,200 / 9,800	1648	1679	.196	7¾R	10½	10	10¾				1-6-53	Standard projectiles & charge. Recovered - piston failed
4386 -9	X285	17.52	8-6	PA-E-6119	10,200 / —	1655	1686	.196	7¼R	10½	10½	10¼				1-6-53	" " " " piston OK
4387 -10	X286	17.53	8-6	PA-E-6119	9,800 / 10,000	1653	1684	.196	10¾R	10¼	10½	10⅝				1-6-53	" " " " " "
4388 -11	X287	17.53	8-6	PA-E-6119	10,200 / 10,400	1659	1690	.196	13R	11⅜	11½	11¼				1-6-53	" " " " piston failed
4389 -12	X256	17.54	8-6	PA-E-6119	9,800 / 10,000	1646	1677	.196	12R	10⅜	10½	–				1-6-53	" " " " " OK
4390 -13	X289	17.52	8-6	PA-E-6119	10,600 / 10,300	1663	1694	.196	10R	10¼	10½	10⅝				1-6-53	" " " " " "
4391 -14	X288	17.53	8-6	PA-E-6119	10,200 / 9,800	—	—	.196	10¾R	10⅝	10⅝	10¼				1-6-53	" " " " " "
4392 -15	X282	17.62	8-6	PA-E-6119	9,600 / 10,200	1648	1679	.196	10¼R	10⅝	10¼	–				1-6-53	" " " " piston failed
4393 -16	X283	17.51	8-6	PA-E-6119	9,700 / 10,000	1655	1686	.196	11½R	10½	10½	10½				1-6-53	" " " " piston O.K.
4394 -17	X281	17.51	8-6	PA-E-6119	9,800 / —	1633	1664	.196	7¼R	10½	10¾	10½				1-6-53	" " " " " "

a Retardation factor = .40 ft./sec/ft.
b Allowable fin spread variation: 10.56 to 10.82 inches

* Denotes heat treated piston.

Signed - O. Hiller

PENETRATION STUDIES

Effect of Wire Through Ogive

Tests on the effect of a wire located on the axis of a liner, on the penetration obtainable with the liner, have in some cases given contradictory results. The experiments described in this report were set up to reduce to a minimum any uncertainties as to the location of the wire. Two schemes were used; both methods used DRC376 bodies and plugs, with DRC342 ogives (T119) and DRA699 nose caps.

In the group of rounds FS938 to FS 952 inclusive the wire, if used, was tightened just previous to firing, by unscrewing the nose cap. Figure 4 shows the assembly scheme. The wire was fastened to the apex of the cone at one end and was passed through a hole in the nose cap located on the center line o· displaced 1/4 in. from the center.

For the group of rounds FS983 to FS 1022 inclusive, two slots approximately 1/2 in. wide and 2 in. long were machined in the side of the ogive, with the long axis of the slot parallel to the slant height of the cone. The two slots in each ogive were placed 90° to each other around the circumference. These slots made it possible to examine the round just before firing to determine both the location of the wire and its tautness. Ten rounds were without wires, ten rounds had the wire drawn taut and secured at the time of assembly, ten rounds were assembled with one half inch of slack in the wires, and the remaining ten rounds were assembled with one inch of slack in the wires. Examination, immediately before firing, indicated that in some cases the supposedly taut wires were not taut. However, the degree of deviation was slight. Figure 5 is a sketch of the experimental arrangement.

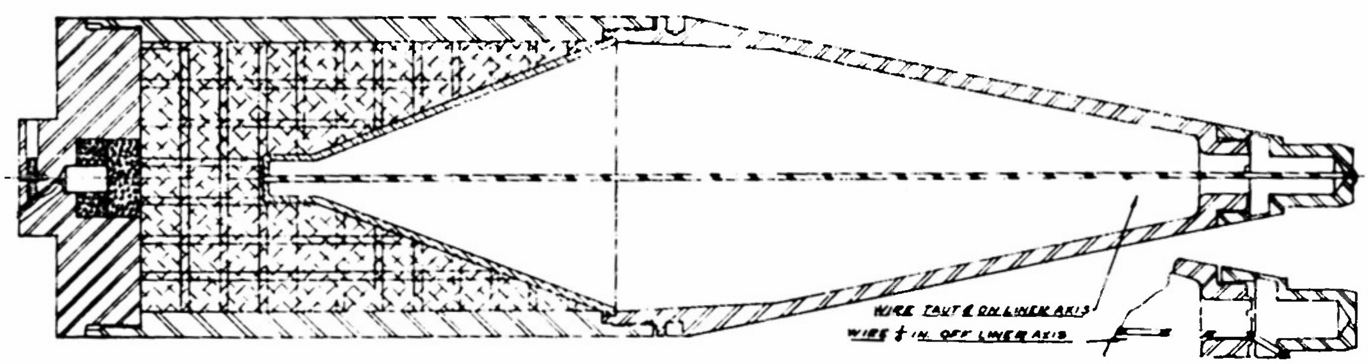


Fig. 4. Test Assembly.

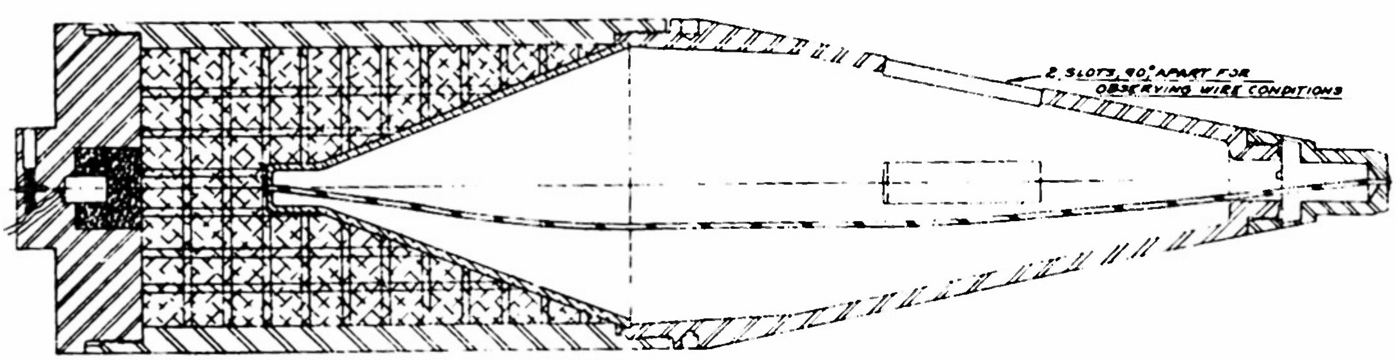


Fig. 5. Experimental Arrangement.

Table V is a record of the penetration results of the two groups. Some rounds were rotated at 15 rev/sec, to cause the wire to be held off the center line by centrifugal force, if any slackness was present. The results of the two groups of rounds show definitely that:

1. If a beryllium copper wire .040 in. in diameter with an .070-inch nylon insulation lies on the axis of the liner the penetration is greatly reduced.

2. If such a wire is slightly slack so that it may or may not be on the axis the results show interference in a portion of the cases.

3. If the wires are quite slack the degrading effect on penetration is greatly reduced. This is especially true for rounds which are rotated.

Although these data indicate that the presence of a wire in the cavity is not detrimental unless it is located in the direct path of the jet, it is advisable to continue the practice of insuring that the wire can not line up along the axis of the cone and interfere with the jet functioning.

Table V
Penetration Data
Effect of Axial Wire On Penetration

Round No.	Lbs Comp B	Penetration (inches M.S.)	Max. Spread (in.)	Std. Deviation (in)	Spin (rev/sec)	Remarks
FS938	2.60	21.62			0	No Wire
FS939	2.60	20.31			"	" "
FS940	2.60	20.56			"	" "
FS941	2.58	20.25			"	" "
FS942	2.60	20.81			"	" "
FS983	2.56	21.56			"	" "
FS984	2.62	19.44			"	" "
FS985	2.58	17.44			"	" "
FS986	2.58	21.56			"	" "
FS987	2.60	19.81			"	" "
		Avg. 20.34	4.18	± .35		
FS988	2.60	17.25			15	No Wire
FS989	2.56	18.31			"	" "
FS990	2.58	17.37			"	" "
FS991	2.58	18.50			"	" "
FS992	2.58	18.19			"	" "
		Avg. 17.92	1.25	± .26		
FS943	2.58	4.06			0	Taut wire on
FS945	2.60	1.50			"	center line
FS947	2.58	2.06			"	" "
FS995	2.60	7.00			"	" "
FS997	2.60	9.12			"	" "
		Avg. 4.75	7.06	± 1.5		
FS998	2.60	4.75			15	Taut wire on
FS999	2.58	4.18			"	center line
FS1000	2.60	7.56			"	" "
FS1001	2.58	3.25			"	" "
FS1002	2.62	8.62			"	" "
		Avg. 5.67	4.37	± 1.0		
FS948	2.60	6.25			0	Wire off ℄ .25 in
FS949	2.58	7.81			"	at front end
FS950	2.56	6.50			"	" "
FS951	2.60	9.31			"	" "
FS952	2.58	6.81			"	" "
		Avg. 7.34	3.06	± .56		(cont'd)

Table V (Cont.)

Round No.	Lbs Comp B	Penetration (inches M.S.)	Max. Spread (in.)	Std. Deviation (in.)	Spin (Rev/Sec)	Remarks
FS993	2.60	19.81			0	Wire slightly slack
FS994	2.58	18.25			"	" " "
FS996	2.60	16.50			"	" " "
		Avg. 18.18	3.31	±.96		
FS1003	2.58	18.93			0	Wire with 1/2" slack
FS1004	2.60	19.62			"	" " " "
FS1005	2.60	15.81			"	" " " "
FS1006	2.60	17.87			"	" " " "
FS1007	2.58	19.87			"	" " " "
		Avg. 18.42	4.06	±.74		
FS1008	2.58	18.56			15	Wire with 1/2" slack
FS1009	2.60	17.81			"	" " " "
FS1010	2.62	17.37			"	" " " "
FS1011	2.60	16.87			"	" " " "
FS1012	2.62	18.25			"	" " " "
		Avg. 17.77	1.69	±.30		
FS1013	2.58	21.25			0	Wire with 1" slack
FS1014	2.58	18.87			"	" " " "
FS1015	2.60	19.31			"	" " " "
FS1016	2.60	17.00			"	" " " "
FS1017	2.60	20.12			"	" " " "
		Avg. 19.31	4.25	±.70		
FS1018	2.60	18.75			15	Wire with 1" slack
FS1019	2.58	18.62			"	" " " "
FS1020	2.60	18.25			"	" " " "
FS1021	2.58	19.37			"	" " " "
FS1022	2.58	17.50			"	" " " "
		Avg. 18.50	1.87	±.31		
FS944	2.58	19.62			0	Wire loose from front of ogive
FS946	2.60	20.31			"	
		Avg. 19.97	0.69	.344		

Notes:
1. DRC376 bodies and plugs; DRC342 ogives (T119); DRA699 nose caps.
2. All rounds loaded at Ravenna Arsenal, BAT Lot No. 24, with Comp B from Holston Lot No. 3-126.
3. All rounds fired at a standoff of ogive and cap plus 1/8" (9.4").

Effect of Tee Configuration—Machined Liners

Further studies of the effect of internal tee configuration upon penetration have been completed. In these studies machined cones were used and the results are compared with those of previously reported experiments with drawn cones. Fig. 6 shows the simple nose ring and three types of tees used. The inspection data for the cones were reported in Table VII of the Twenty-Ninth Progress Report. The penetration data are presented in Table VI. The following tabulation shows the penetration of drawn and machined DRB398 cones in similar tees.

	Drawn (in)	Mach. (in)
Nose Ring	20.8	19.9
DRC314	16.0	15.8
DRC314HW10	16.2	19.2
DRC314HW11	19.7	20.0

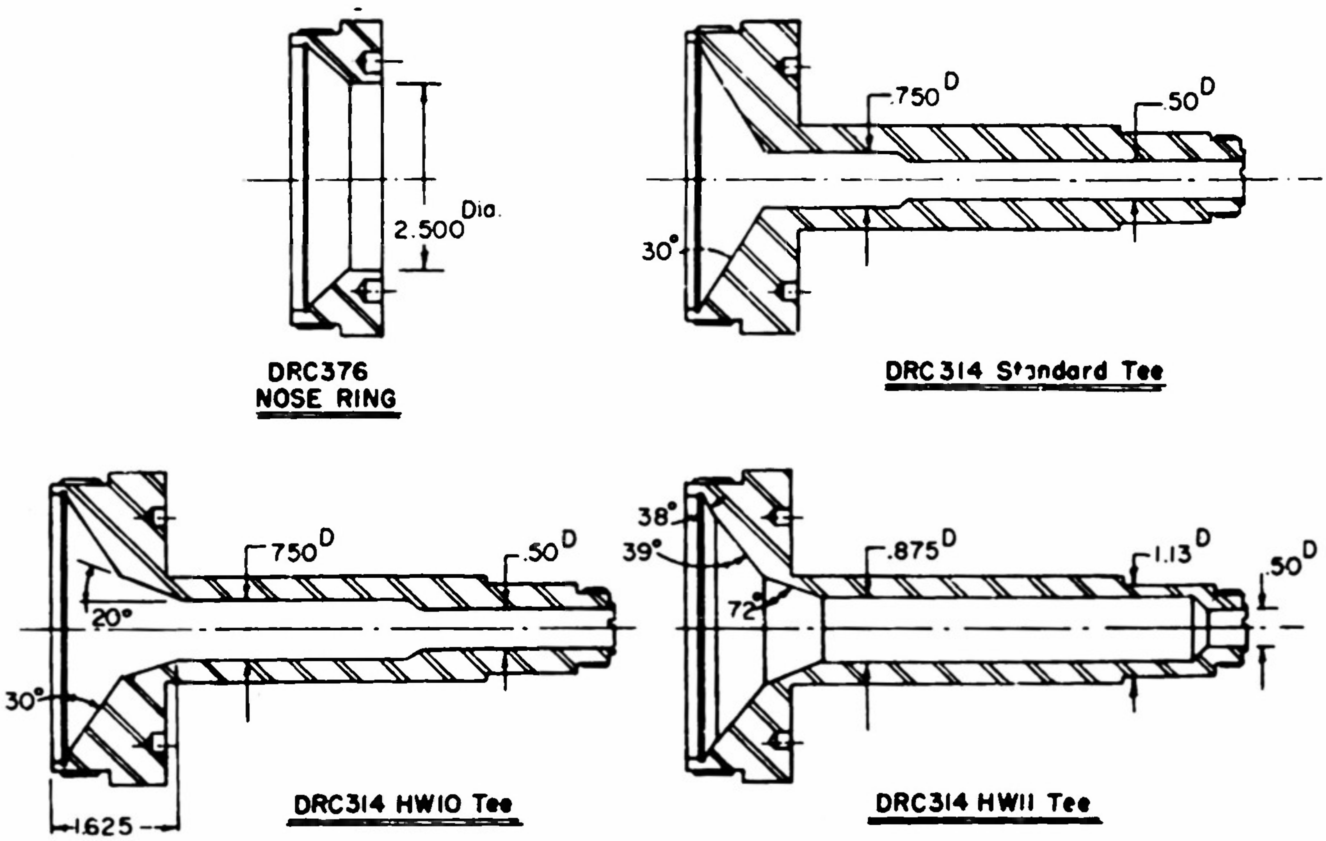


Fig. 6. Nose Ring and Three Tee Configurations.

Table VI
Penetration Data
Machined Liners — Tee Configuration

Round No.	Lbs. Comp B	Tee	Penetration (Inches M.S.)	Max. Spread (in.)	Std. Dev. (in.)
FS647	2.58	DRC314	16.94		
FS648	2.54	"	15.25		
FS649	2.58	"	16.25		
FS650	2.60	"	13.88		
FS651	2.58	"	16.69		
			Avg. 15.80	3.06	±1.18
FS652	2.58	DRC314HW10	19.12		
FS653	2.58	"	20.00		
FS654	2.56	"	18.50		
FS655	2.56	"	18.81		
FS656	2.62	"	19.39		
			Avg. 19.16	1.50	±0.58
FS657	2.56	DRC314HW11	20.44		
FS658	2.58	"	19.31		
FS659	2.60	"	20.17		
FS660	2.58	"	19.56		
FS661	2.58	"	20.44		
			Avg. 19.97	1.13	±0.52
FS632	2.58	Nose Ring (DRC376)	19.94		
FS633	2.58		20.56		
FS634	2.60		19.56		
FS635	2.58		19.12		
FS636	2.58		20.50		
			Avg. 19.93	1.44	±.62

Notes:
1. DRC376 bodies and plugs; booster in base plug.
2. Loaded at Ravenna Arsenal, BAT Lot No. 23, with Composition B from Holston Lot 3-126.
3. Tested at Erie Ordnance Depot, 0 rev/sec, 7.5 inches standoff.

With the notable exception of the DRC314 HW10 tee there is no significant difference between the behavior of the drawn and machined cones. The intermediate degree of clearance provided by the DRC 314HW10 tee is apparently sufficient for the machined liner but is not sufficient for the drawn liner. Reference should be made to the Twenty-Fourth Progress Report where the effect of tee configuration upon the performance of DRB2 and DRB398 cones was compared. The DRC314 tee did not interfere with the normal penetration of the DRB2 cone. It is now apparent that the reason is not merely because the DRB2 cone is machined from copper bar while the DRB398 cone is drawn.

A visual examination of tee fragments and slugs has disclosed that the diameter of the slug from the DRB398 cone is larger than the .75-inch bore of the DRC314 tee, but is less than the .875-inch bore of the DRC314 HW11 tee. This observation suggests the possibility that the determining factor might be slug diameter. Slugs from DRB2 cones have been recovered and usually measure approximately .70 in. at their largest diameter. These studies are being continued.

Future Program

1. Continue tests to determine the effect of interior tee configuration upon penetration.

2. Continue scaling studies with smaller liners.

3. Composite cones. The penetration behavior of steel and aluminum cones having thin copper inserts, and of copper cones with thin aluminum inserts, will be compared with homogeneous copper cones. Initial tests will be at 0 and 25 rev/sec.

4. Cones made of zinc and aluminum are to be tested for penetration. Penetrations approaching those of copper cones have recently been reported for cones of certain zinc and aluminum alloys.

5. Loading tests. The effect of melt holding time upon performance of two different lots of Composition B is to be determined.

Jolt and Jumble Tests, Base Element, T222E5

Twelve T222E5 base elements (Fig. 10, Twenty-Fifth Progress Report) were sent to Picatinny Arsenal for standard Jolt and Jumble tests. Six were tested without tetryl leads or pellets and the remaining six were equipped with a full explosive train.

The six base elements without tetryl leads and pellets were tested in groups of two. They were subjected to the action of the jolt machine for three hours and then to the jumble machine for three hours. The base elements were then disassembled and examined. No case of arming or damage was found.

The six base elements, containing the tetryl lead and tetryl pellets, were also tested in groups of two with the usual three hours in the jolt machine and three hours in the jumble machine. Examination of the elements after testing showed no damage or arming.

On the basis of these tests it is planned to test the base elements in HEAT rounds.

Switch For T267 Superquick and Delay Fuze

A modified type of base element, to include .05 sec delay action, as well as superquick action has been designated T267. (Fig. 27, page 31, Twenty-Second Progress Report). This base element is almost ready for field tests. A switch, to fit the T119 projectile, has been designed and is shown in Fig. 7. This switch makes the selection of the type of functioning, superquick or delay, possible by the use of a screwdriver or similar device.

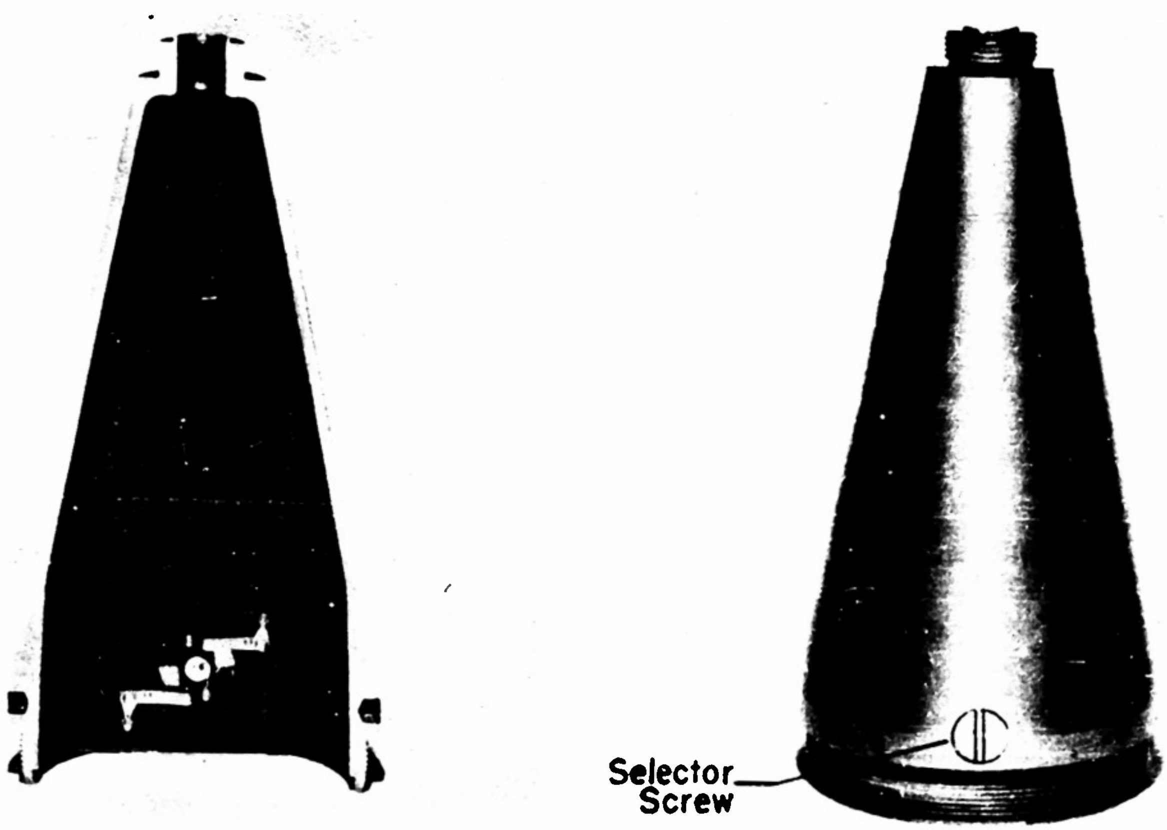


Fig. 7. Selector Switch for T267 Fuze.
Superquick or Delay.

Comparison of Voltage Output of DRA726 and DRA496-2 Nose Elements

Laboratory comparisons of the electrical voltage output of the two crystal assemblies have been made. In this test a 2 1/2-lb weight traveling 4 ft/sec was allowed to strike the exposed crystal assembly mounted on a rigid base. The crystal was connected across a 2000-ohm load and an oscilliscope record of the time-voltage phenomena was taken. Fig. 8 shows the two crystal assemblies, Fig. 9 is a drawing of the experimental procedure and Fig. 10 shows copies of the oscilliscope records. The attenuation used for the DRA496-2 nose element was 30 as compared to an attenuation of 1 for the DRA726 nose element. Allowing for the attenuation, the voltage output for the DRA726 nose element was 8 volts and for the DRA496-2 nose element 350 volts. Thus the DRA726 nose element is considerably less powerful than the earlier form.

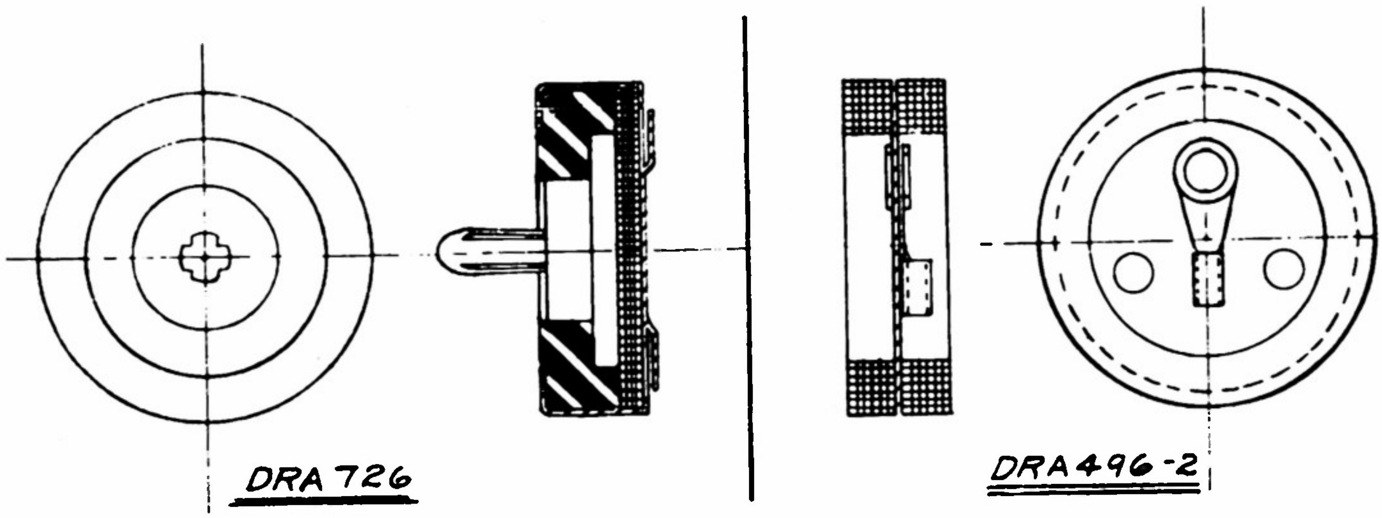


Fig. 8. Crystal Assemblies - DRA726 and DRA496-2.

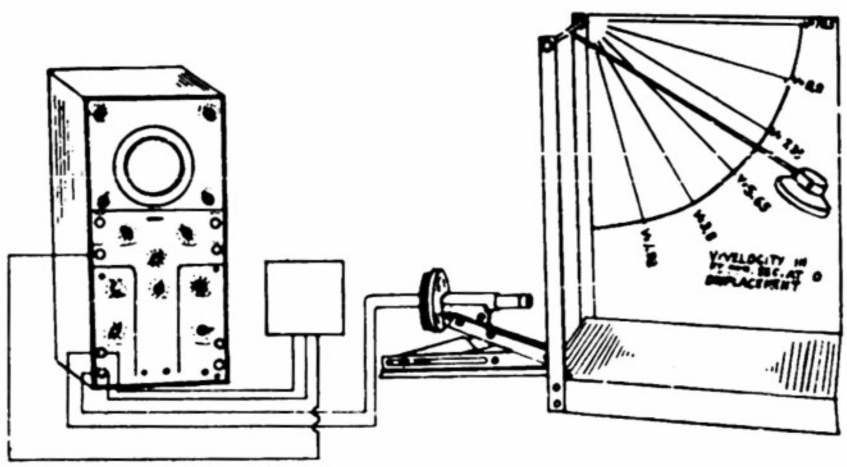
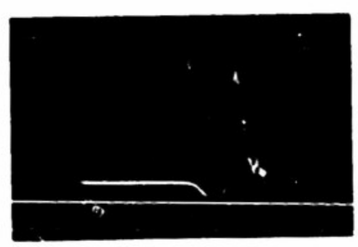


Fig. 9. Experimental Arrangement.
Nose Element Tests.



DRA726

DRA496-2

Fig. 10. Oscilloscope Records.
Nose Element Time - Voltage Tests.

Field Tests On DRA726 Nose Element

Ten DRA726 (Fig. 8) nose elements were assembled in T138E57 projectiles. The projectiles were inert loaded and equipped with spotting charges and T208 base elements. These rounds were fired against a 4-inch wood bursting screen at a range of 100 yards. All ten rounds functioned satisfactorily. A group of 50 T138E57 HEAT rounds are being prepared to test the nose element in actual live rounds.

This new nose element assembly has the following advantages:

1. The crystal can be inserted after the projectile is loaded.

2. The crystal is sealed against moisture and corrosion.

3. The crystal is confined and hence is held in position even though it may be cracked or shattered. Tests show that a shattered crystal will generate sufficient voltage if confined to its original shape. Table VII is a copy of the firing record.

Investigation of 9GA20 Selenium Rectifiers

The electrical charge required for detonating a HEAT shell could be generated by the crystal during ck, stored in a condenser and o schai ed through the detonator when a se s tch is closed by the impact of the ectile on the target. This study shows the results of some tests using International Resistor Company's 9GA20 No. 1 rectifiers for the purpose of insulating the condenser from the generating source after the charging action. Fig. 11 is a schematic diagram of one means for accomplishing this type of action. An advantage of this type of functioning is that an inertia-actuated switch could be placed in parallel with the nose switch to provide graze sensitivity. Figs. 12 and 13 show the data for a single 9GA20 No. 1 rectifier in series with a DRA496-2 nose element and a .001 µf condenser. Figs. 14 and 15 show the data for a single 9GA20 No. 1 rectifier in series with a .001 µf condenser.

In each case the time required for the voltage to leak to 1/2 of the initial voltage is well over the time of flight to 1000 yards and in the one case is ample for much longer ranges. Therefore, these rectifiers will be tried in field tests.

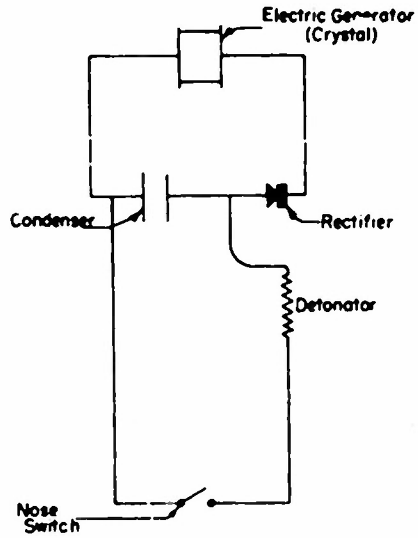


Fig. 11. Schematic Wiring Diagram.

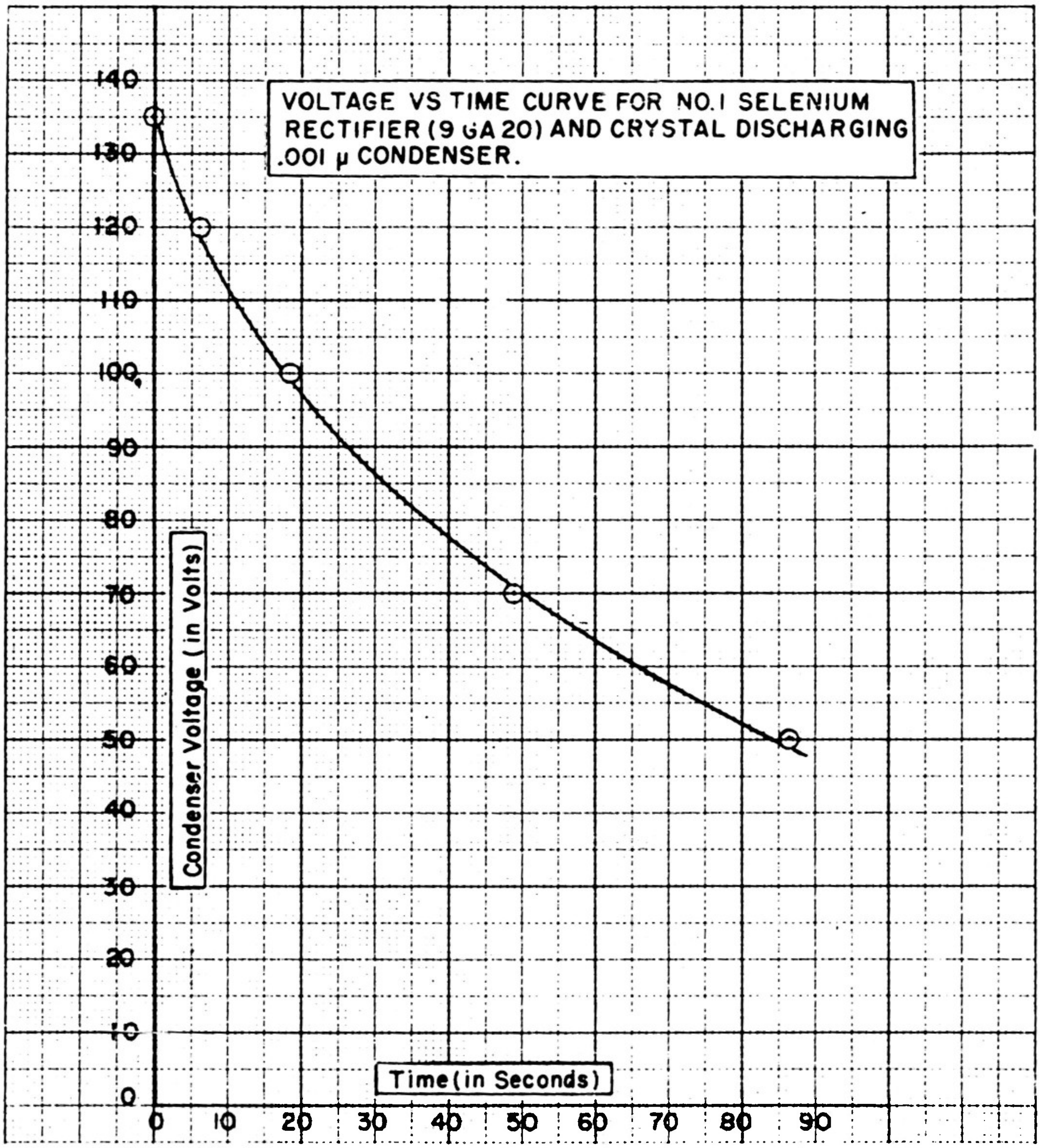


Fig. 12. Voltage Versus Time Curve.
For No. 1 Selenium Rectifier (9GA20) and Crystal Discharging Condenser.

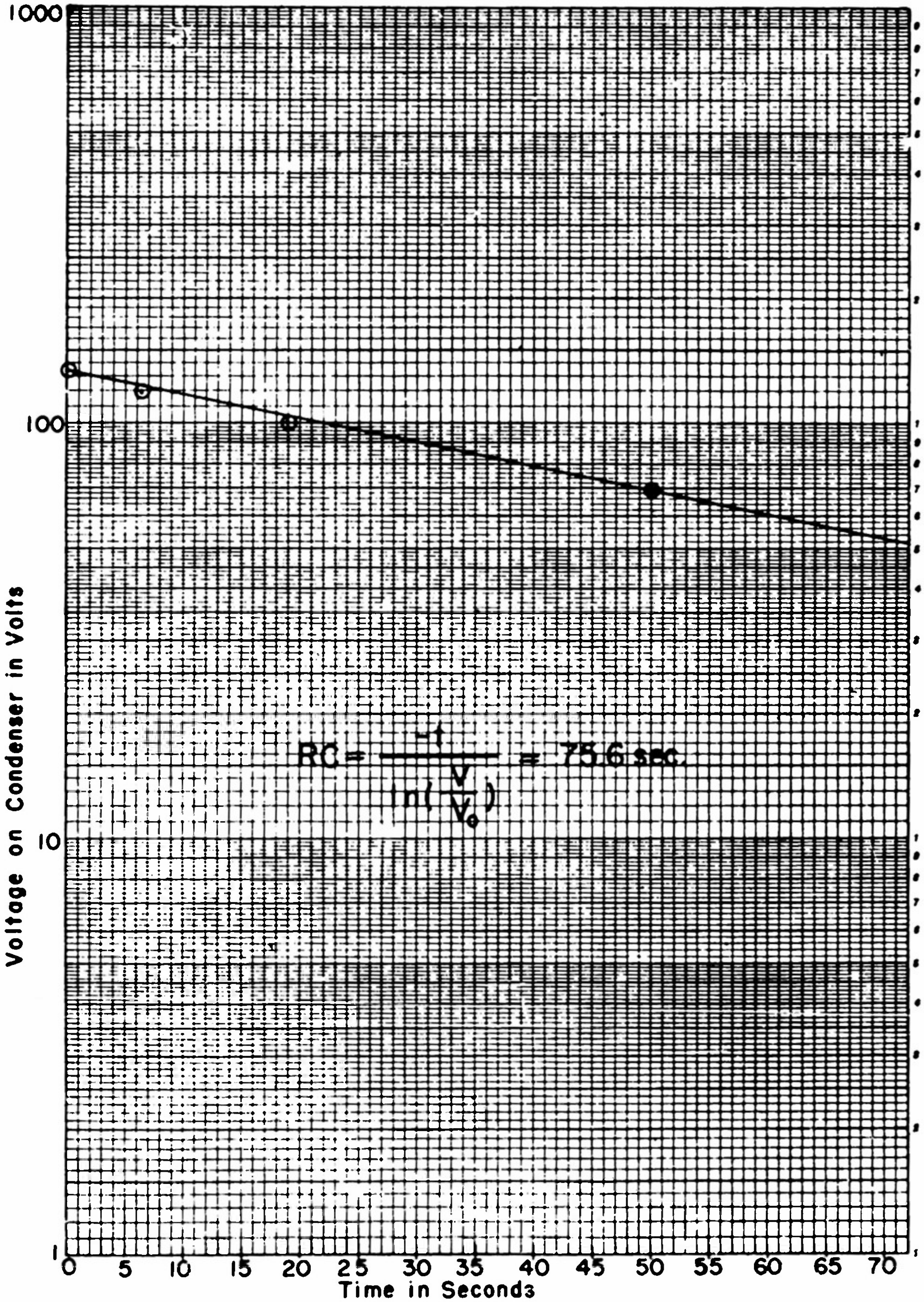


Fig. 13. Voltage Versus Time.
9GA20 No. 1 Crystal In Series.

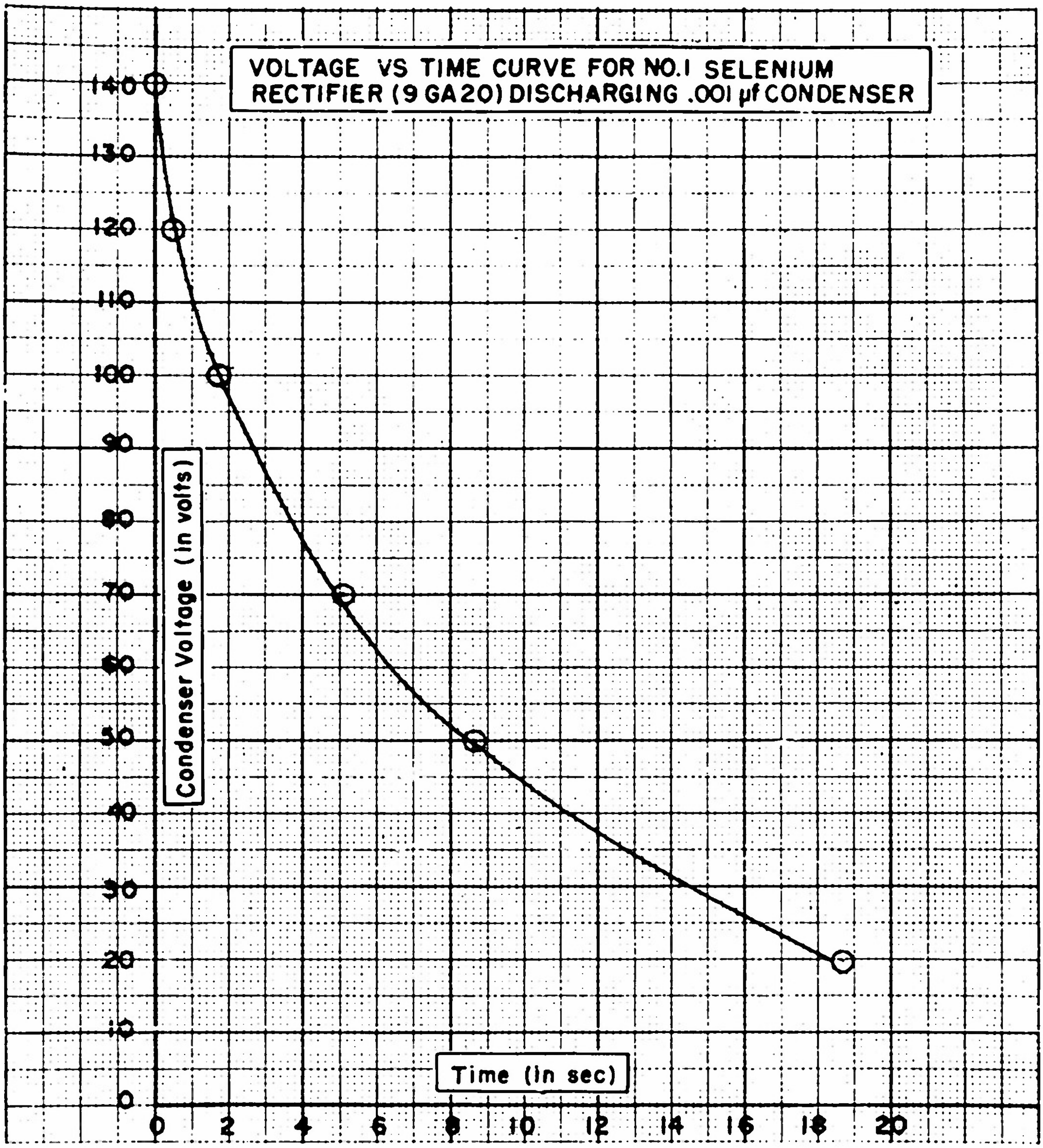


Fig. 14. Voltage Versus Time Curve.
For No. 1 Selenium Rectifier (9GA20) and Discharging Condenser.

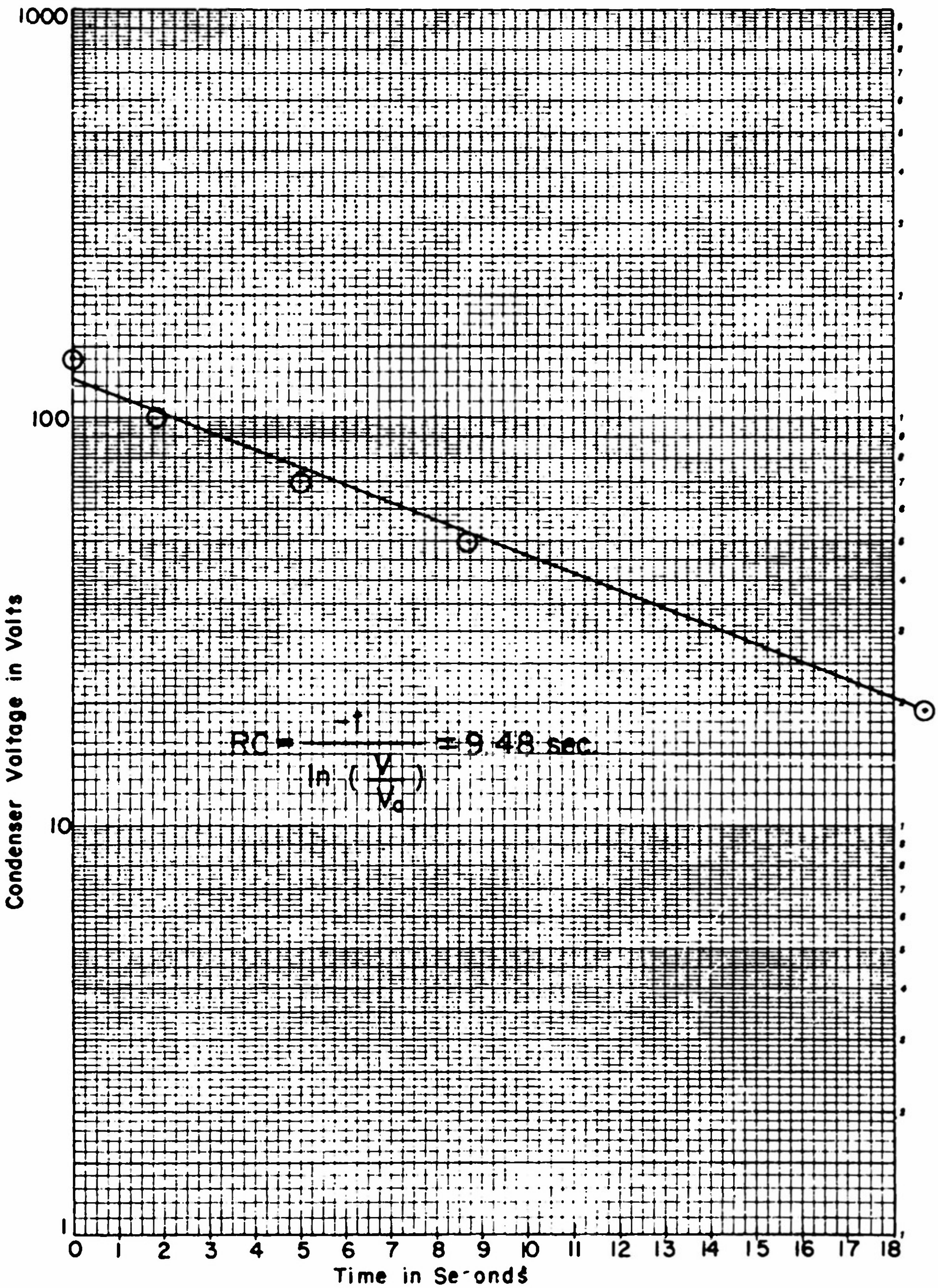


Fig. 15. Voltage Versus Time.
9GA20 No. 1.

Table VII
Firing Record
Field Tests On DRA726 Nose Element

Date 2-4-63 Program Supp. II

T222E6 Fuze Test, Superquick Test of New Nose Element Design

PROJECTILE

Model T138

Type E37A

Weight (Nominal) ______

C.G. Location ______

Bourrelet Dia.(Nom.) 4.132 -.002

Special Features T222E6 Fuze System with new plug-in nose element (DRA 726; and T208E7 base element.

Retardation factor =.246 ft/sec/ft.

TEMPERATURES
Ambient - 38°F
Magazine Temps.
Max. 74°
Min. 70°
Pres. 74°
Room 72°

TEST GUN

Model T19

Type 105mm Recoilless

Length of Tube 85 in.

Twist of Rifling 1-200

Sighting Equipment M12 Elbow Telescope

Bore Dia. (Lands) 4.124 +.001 in.

Tube 12504
Chamber T19 No. 6
Vent Ring 72 B0B26

MISCELLANEOUS DATA

Range Pendulum Mount To Bursting Screen 50yds.

Propellant PA 30240 M57 Primer

Type M10MP web .0836 in Charge Wt. 8 lb 4oz.

T6 Reinforced cases with T6 polyethylene liners

Proof Director E. Huffman

Observers W. Russell, W. Davies, M. Tearie, E. McLean, L. Glitch

Solenoid fired mechanical

Round No.	Time of Flight	Powder Charge (lb - oz)	Recoil (in)	Wind Vel. & Dir.	Chamber Pressure M-3 Cu	Muzzle Velocity Instr.	Muzzle Velocity Actual	Elev. (mils)	Azimuth (mils)	Position of Hit Vert.	Position of Hit Horiz.	Corrected Position of Hit - mils Vert.	Corrected Position of Hit - mils Horiz.	Bourrelet Diameter Front	Bourrelet Diameter Rear	Clearance Front	Clearance Rear	Observations
4428-1		8-4	—		12,400		Fired into recovery box. Not enough sawdust to stop the projectile.											
4429-2		8-4	5 F		11,700			Functioned at screen										
4430-3		8-4	5 F		11,900			Functioned at screen										
4431-4		8-4	6.5		12,000			Functioned at screen					NOTES:					
4432-5		8-4	5½F		13,100			Functioned at screen					All rounds were loaded and fired as single units					
4433-6		8-4	4¼F		—			Functioned at screen					No wadding was used					
4434-7		8-4	1 F		12,200			Functioned at screen					All rounds were fired through a 4-inch bursting					
4435-8		8-4	5¼F		12,600			Functioned at screen					screen - 55 yds from the muzzle.					
4436-9		8-4	3 F		12,000			Functioned at screen										
4437-10		8-4	8¼		12,600			Functioned at screen										
4438-11		8-4	3¾		12,000			Functioned at screen										

Signed - O. Miller.

Future Program

1. Testing of base elements, T222 E5, in live HEAT projectiles.

2. Testing of base element, T267, for .05 sec delay and superquick action.

3. Evaluation of the nose element DRA 726 for sensitivity by firing against a 1 inch burster screen.

4. Testing of the nose element DRA 726 in live HEAT rounds.

5. Testing of the "inverted" firing system using 9GA20 No. 1 rectifiers and condensers in projectiles with burster charges.

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